

## Six New *Agelas* Species (Demospongiae: Agelasida: Agelasidae) from Kosrae Island, The Federated States of Micronesia

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### ABSTRACT

This paper describes six new species of sponges in the genus *Agelas* from Kosrae Island, The Federated States of Micronesia. Most Agelasid sponges are known from only tropical regions. All the new *Agelas* species; *A. fragum* n. sp., *A. kosrae* n. sp., *A. purpurea* n. sp., *A. bakusi* n. sp., *A. vansoesti* n. sp. and *A. incrustans* n. sp. are compared with other valid species that were studied. Six new species differ from the other species by morphology, growth form, skeletal fibres, habitats and spicule size. *Agelas fragum* n. sp. is characterized by its tuberculate surface and primary fibres with brush-like spicules. *Agelas kosrae* n. sp. is differs in skeletal structure and have tertiary fibres. *Agelas purpurea* n. sp. is characterized by primary, secondary and tertiary fibres are all cored with spicules. *Agelas bakusi* n. sp. is similar to *Agelas clathrodes* in shape, but differs in the primary fibres. *Agelas vansoesti* n. sp. is characterized by having acanthostongyles. *Agelas incrustans* n. sp. is distinguished by its encrusting and not cavernous interior.

**Keywords:** Porifera, Agelasida, Agelasidae, *Agelas*, new species, Kosrae, Micronesia

### INTRODUCTION

Little is known about the sponge fauna from Kosrae, one of four Federated States of Micronesia (FSM). The sponge fauna of FSM are summarized by Kelly-Borges and Valentine (1995), based upon the work of de Laubenfels (1954) and Bergquist (1965). De Laubenfels (1954) report one species, *Agelas mauritiana* from the Marshall Islands. No species of *Agelas* were recorded from Truk and Ponpei Island, located near Kosrae. Studies of the genus *Agelas* in tropical regions were made by Duchassaing De Fonbressin and Michelotti (1864), Carter (1883), Wilson (1902), Wiedenmayer (1977), Thomas (1980, 1981, 1998), Pulitzer-Finali (1982, 1986, 1996), Alcolado (1984), Hoshino (1985), Zea (1987), Van Soest and Stentoft (1988), Lehnert and Van Soest (1996, 1998) and Mothes et al. (2007). Assmann et al. (2001) reported the new species *A. cerebrum* and recorded other *Agelas* species from the Caribbean. De Voogd et al. (2008) reported one new species, *A. linnaei* from Indonesia and compared it with all other *Agelas* species occurring in the Indo-west Pacific.

### MATERIALS AND METHODS

Sponge collections were made from the region of Kosrae, the most eastern of the Caroline Islands. The island is located approximately 370 miles (600 km) north of the equator ( $5^{\circ}19'N$ ,  $162^{\circ}59'E$ ) between Guam and the Hawaiian Islands. They were taken from depths of 10–50 m using scuba diving, 23–30 Jan 2011, 8–15 Jan 2012, 18–28 Oct 2012 and 20–24 Nov 2013. The GPS coordinates of each site were recorded (Table 1, Fig. 1). Collected specimens were frozen and some preserved in 95% ethyl alcohol and were identified based on their morphological characters. The external feature of sponges was observed with a stereo microscope (Stemi SV 6, Carl Zeiss, Jena, Germany). The skeletal arrangements and spicules were studied under a light microscope (Axioscope II, Carl Zeiss) and SEM (HITACHI S-3500; Hitachi, Tokyo, Japan).

### SYSTEMATIC ACCOUNTS

Order Agelasida Hartman, 1980

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**Table 1.** Geological information for collection sites

Station	Collection site	GPS
1	Molsron Tukunsru	5° 17'07"N, 162° 54'11"E
2	Foko Fukunral	5° 15'32"N, 162° 59'22"E

**Fig. 1.** A map showing the collection sites.

Family Agelasidae Verrill, 1907

Genus *Agelas* Duchassaing & Michelotti, 1864**<sup>1\*</sup>Agelas fragum n. sp. (Fig. 2)**

**Type specimen.** Holotype (MABIK IV00151590), Molsron Tukunsru Village, Kosrae, Micronesia, 22 Oct 2012, Rho HS, by scuba, depth 10 m, deposited in the MABIK, Seocheon, Korea.

**Description.** Thin encrusting small pieces, size up to 9 × 6 × 0.1–0.3 cm, more or less tuberculated on the surface, attached tightly to the broad rocky substratum. Microscopically the tubercles are rugose with openings and with spicule clusters that protrude from the surface. Surface of many round projecting conules (1–2 mm height) with oscules. Texture hard at surface, soft at bottom. Color dark red.

**Skeleton.** Primary fibres cored and echinatated, 65–78–232 µm in diameter, the end of primary fibres have densely echinatated spicules. Secondary fibres 35 µm in diameter. Secondary fibres make large meshes, less echinatated at the sponge base. The top of the surface, tubercle has many echinatated brush-like bundles of spicules, mixed with thin smooth Acanthostyles. Tertiary fibres 20–30 µm in diameter, no echinatating spicules.

**Spicules.** Acanthostyles 110–200 × 10–15 µm, number of spine whorls 11–17.

**Etymology.** This species named after the strawberry-like surface characteristics of the specimen.

**Remarks.** This sponge is similar to *Agelas nakamurari* Hosshino, 1985 from the Ryukyu Islands, Japan, thickly encrusting with orange to red color. The surface of *A. nakamurari* is smooth with uneven and irregularly meandering surface grooves whereas our specimen is rough with tubercles. Sizes of spicules are larger than those of our new species.

**<sup>2\*</sup>Agelas kosrae n. sp. (Fig. 3)**

**Type specimen.** Holotype (MABIK IV00151591), Molsron Tukunsru Village, Kosrae, Micronesia, 22 Oct 2012, Rho HS, by scuba depth 15 m, deposited in the MABIK, Seocheon, Korea.

**Description.** Irregular elongated repent sponge with several branches, size up to 20 × 6 × 1.5–2 cm thick. Some wide parts of sponge attached tightly to the substrate. Surface smooth. Texture firm, compressible and hard to tear. Oscules sparse on the surface. Color live, purple on the surface and beige in the choanosome.

**Skeleton.** Primary fibres rarely cored and rarely echinatated, 100–200 µm in diameter. Secondary fibres echinatated, 30–60 µm in diameter. Secondary fibres meshes 83–163–232 µm in diameter. Tertiary fibres 10–20 µm in diameter are very rarely echinatated.

**Spicules.** Acanthostyles 110–140 × 6–8 µm, number of spine whorls 19–22. Acanthoxeas 150–170 × 6–8 µm, number of spine whorls 18–22.

**Etymology.** This species is named after the type locality, Kosrae, Micronesia.

**Remarks.** This new sponge is similar to *Agelas cervicornis* (Schmidt, 1879) in branching type but different in skeletal structure, and no tertiary fibers.

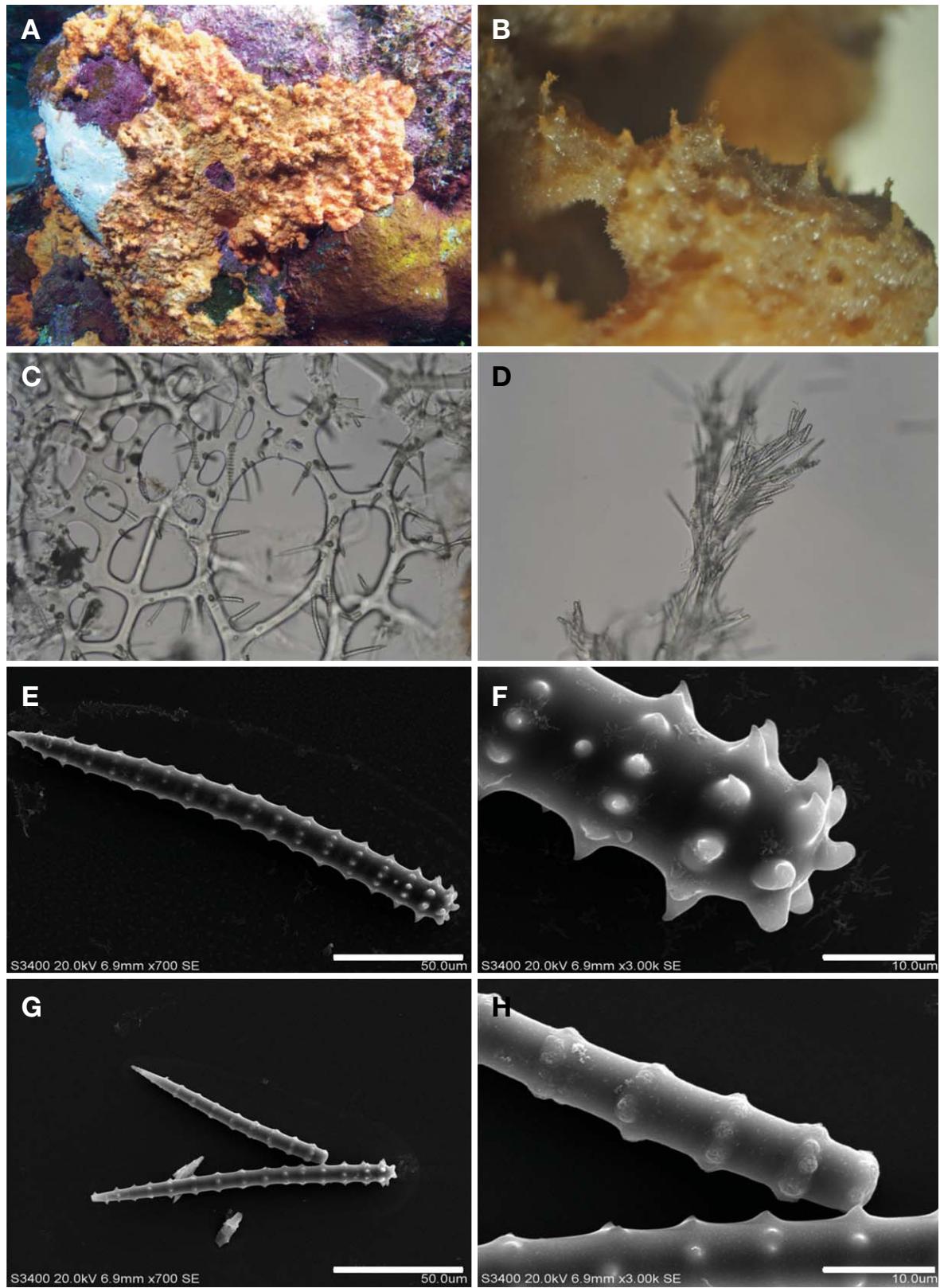
**<sup>3\*</sup>Agelas purpurea n. sp. (Fig. 4)**

**Type specimen.** Holotype (MABIK IV00151592), Molsron Tukunsru Village, Kosrae, Micronesia, 22 Oct 2012, Rho HS, by scuba, depth 15 m, deposited in the MABIK, Seocheon, Korea.

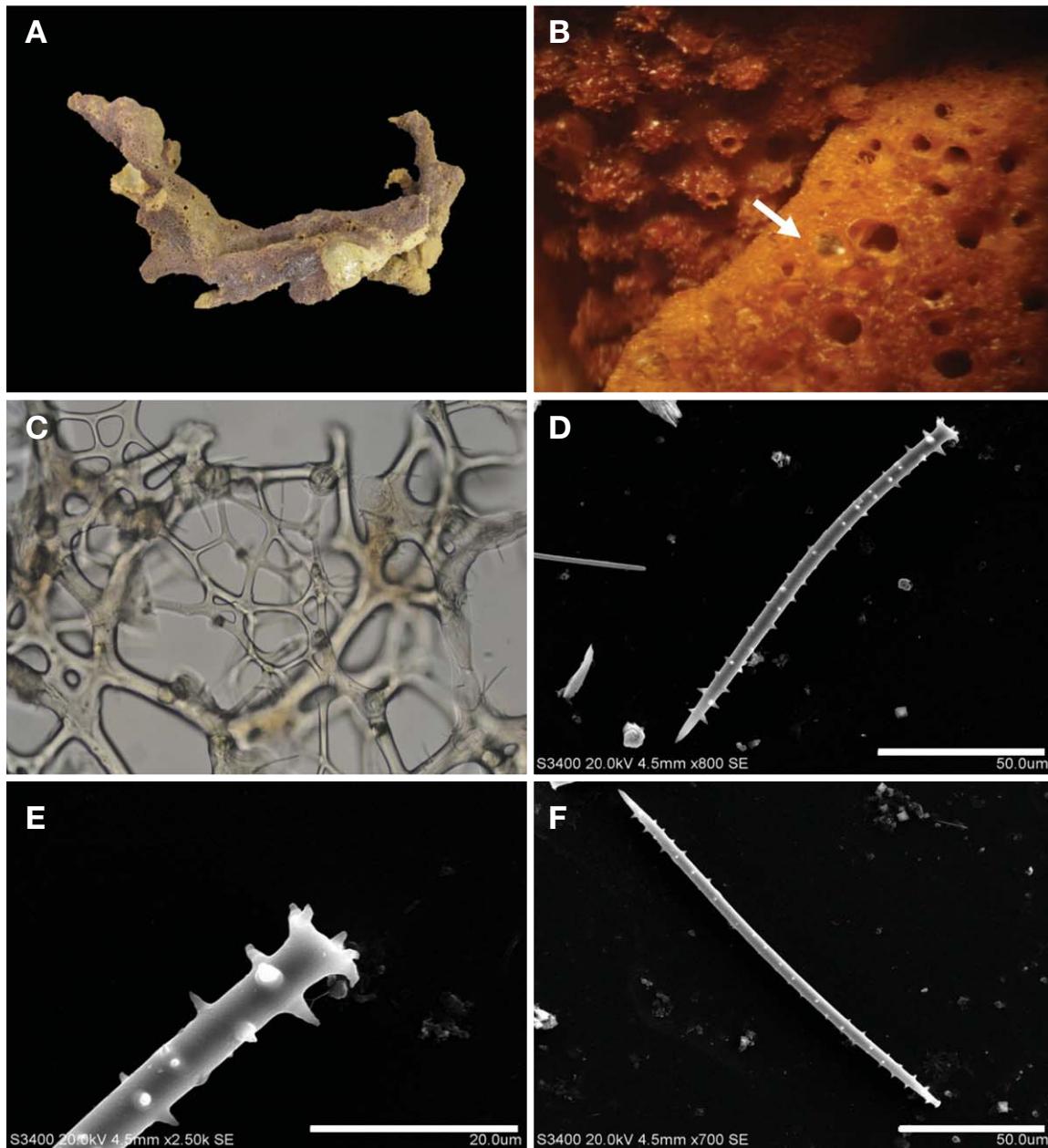
**Description.** Subcylindrical, irregular branched, size up to 13 × 2 × 1.8 cm, attached to the sponge *Agelas kosrae*. Two specimens not fused to each other as they grow separately but adherent. Surface rough with small tubes, and numerous elevated oscules 2–5 mm in diameter. Texture soft and compressible. Color dark purple in life. This sponge is less dense than *A. kosrae*.

**Skeleton.** Primary fibres, 50–100 µm in diameter, heavily cored; secondary fibres, 30–40 µm diameter, cored; tertiary fibres 10 µm in diameter, cored. All fibres rarely echinatated; free spicules occur in the choanosome.

Korean name: <sup>1\*</sup>딸기아겔라스해면(신칭), <sup>2\*</sup>코스레아겔라스해면(신칭), <sup>3\*</sup>보라아겔라스해면(신칭)



**Fig. 2.** *Agelas fragum* n. sp. A, Entire animal (*in situ*); B, Surface of sponge; C, Skeletal structure; D, Terminal brush of spicules; E, Acanthostyle; F, Head of spicule; G, Thin acanthostyle; H, Head of spicule. Scale bars: E, G=50  $\mu$ m, F, H=10  $\mu$ m.



**Fig. 3.** *Agelas kosrae* n. sp. A, Entire animal; B, Surface of sponge (arrow); C, Skeletal structure; D, Acanthostyle; E, Head of acanthostyle; F, Acanthoxea. Scale bars: D, F=50  $\mu$ m, E=20  $\mu$ m.

Spicules. Acanthoxeas  $150\text{--}180 \times 6$   $\mu$ m, number of spine whorls 20–21. Acanthostyles  $150\text{--}220 \times 5\text{--}8$   $\mu$ m, number of spine whorls 19–21.

**Etymology.** This species named after the live color purple.

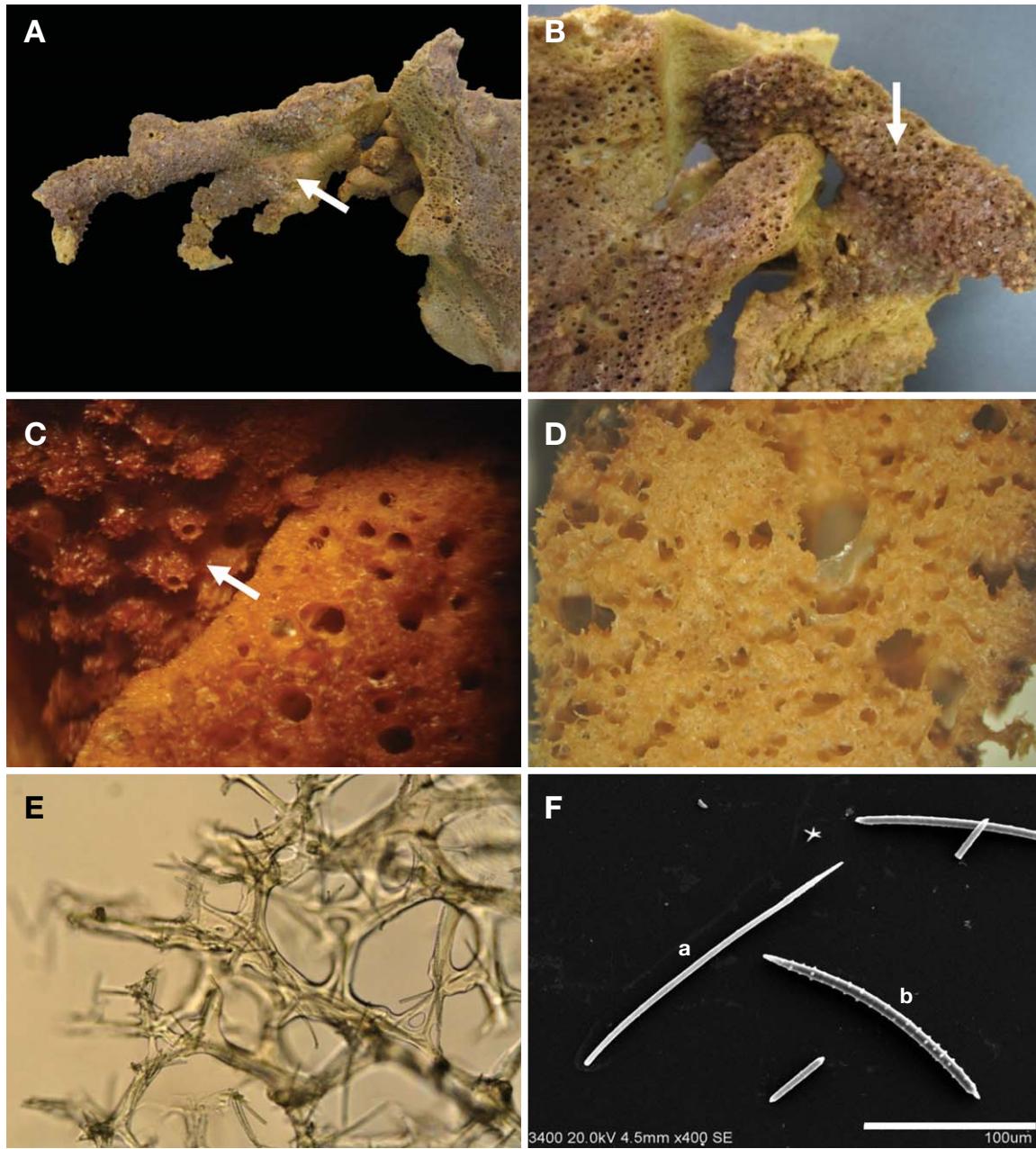
**Remarks.** This new species is similar to *A. kosrae* but differs in the skeletal structure. The primary, secondary and tertiary fibres are all cored. Texture is softer than in *A. kosrae*.

#### <sup>1\*</sup>*Agelas bakusi* n. sp. (Fig. 5)

**Type specimen.** Holotype (MABIK IV00151593), Foko Funksral, Kosrae, Micronesia, 19 Jan 2011, Rho HS, by scuba, depth 17 m, deposited in the MABIK, Seocheon, Korea.

**Description.** Thickly encrusting, size up to  $22 \times 20 \times 2\text{--}3$  cm. Surface smooth with many hole-like pits. Consistency

Korean name: <sup>1\*</sup>바쿠시아겔라스해면 (신칭)



**Fig. 4.** *Agelas purpurea* n. sp. A, Entire animals (arrow); B, Associated two sponges (arrow); C, Surface of sponge (arrow); D, Perpendicular section; E, All fibres cored with spicules; F, Spicules (a, Thin acanthostyle; b, Acanthoxea). Scale bar: F=100 µm.

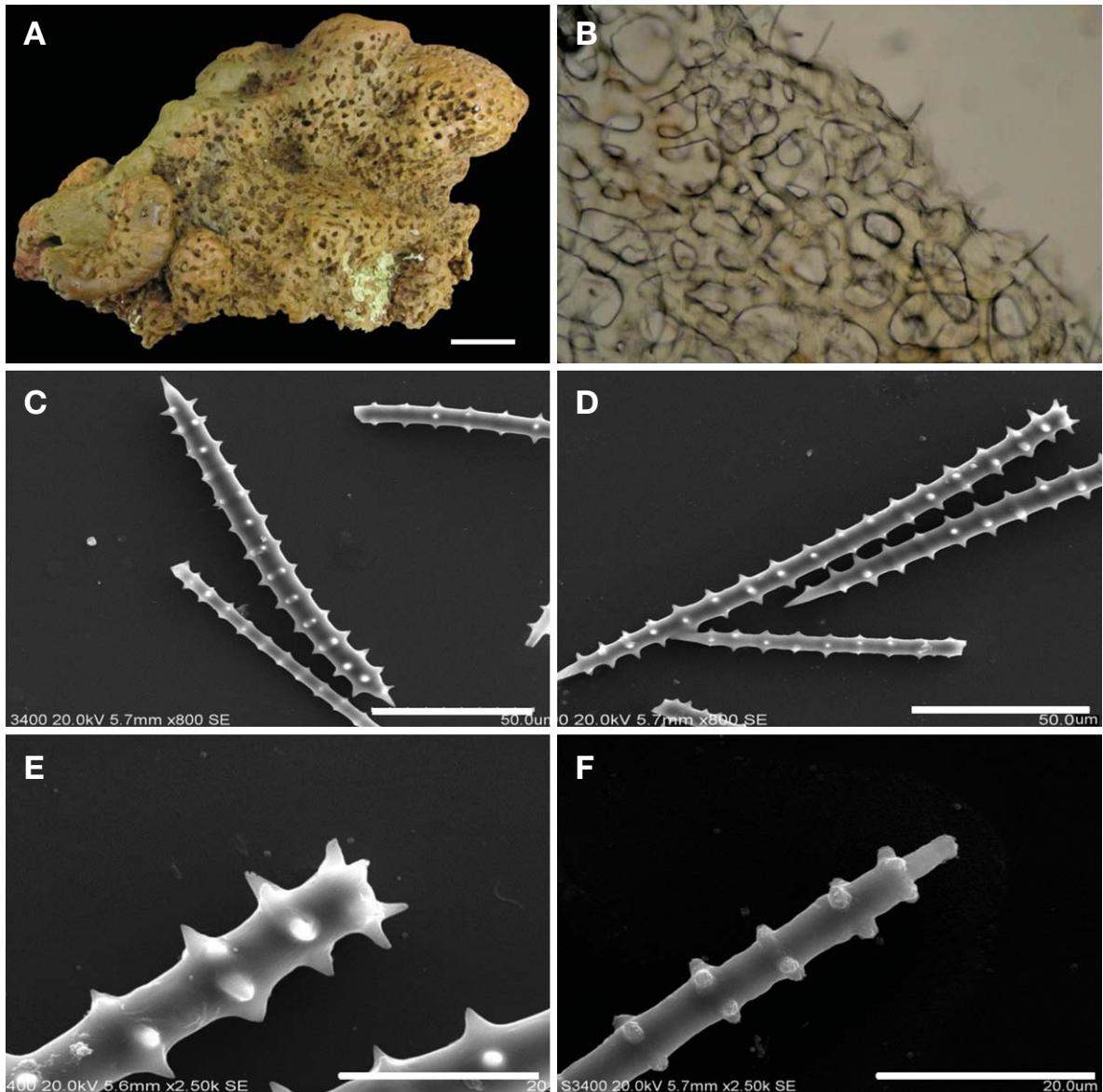
firm. Color orange in life. Cavernous interior.

**Skeleton.** Ectosome consists of a thick membrane with free spicules (mostly acanthoxeas) and mixed fibres. Choanosome consists of a dense network of primary and secondary fibres, not distinct. Primary fibres 50–130 µm in diameter, lightly cored with spicules, echinated and reticulated. Secondary fibres 40–70 µm in diameter, rarely echinated; meshes 50–230 µm in diameter. No tertiary fibres. Choanosome weak

cavernous, many spicules.

**Spicules.** Acanthostyles 150–200 × 8–10 µm, acanthoxeas 140–250 × 6–8 µm. Number of spine whorls, acanthostyles 10–18, acanthoxeas 14.

**Etymology.** This species name *bakusi* is named after Dr. Gerald J. Bakus who is a professor in the department of Biological Sciences, University of Southern California, a marine ecologist and a sponge taxonomist.



**Fig. 5.** *Agelas bakusi* n. sp. A, Entire animal; B, Fibre structure; C, Acanthoxea; D, Acanthostyle; E, Head of spicule; F, Thin Acanthostyle. Scale bars: A=3 cm, C, D=50 µm, E, F=20 µm.

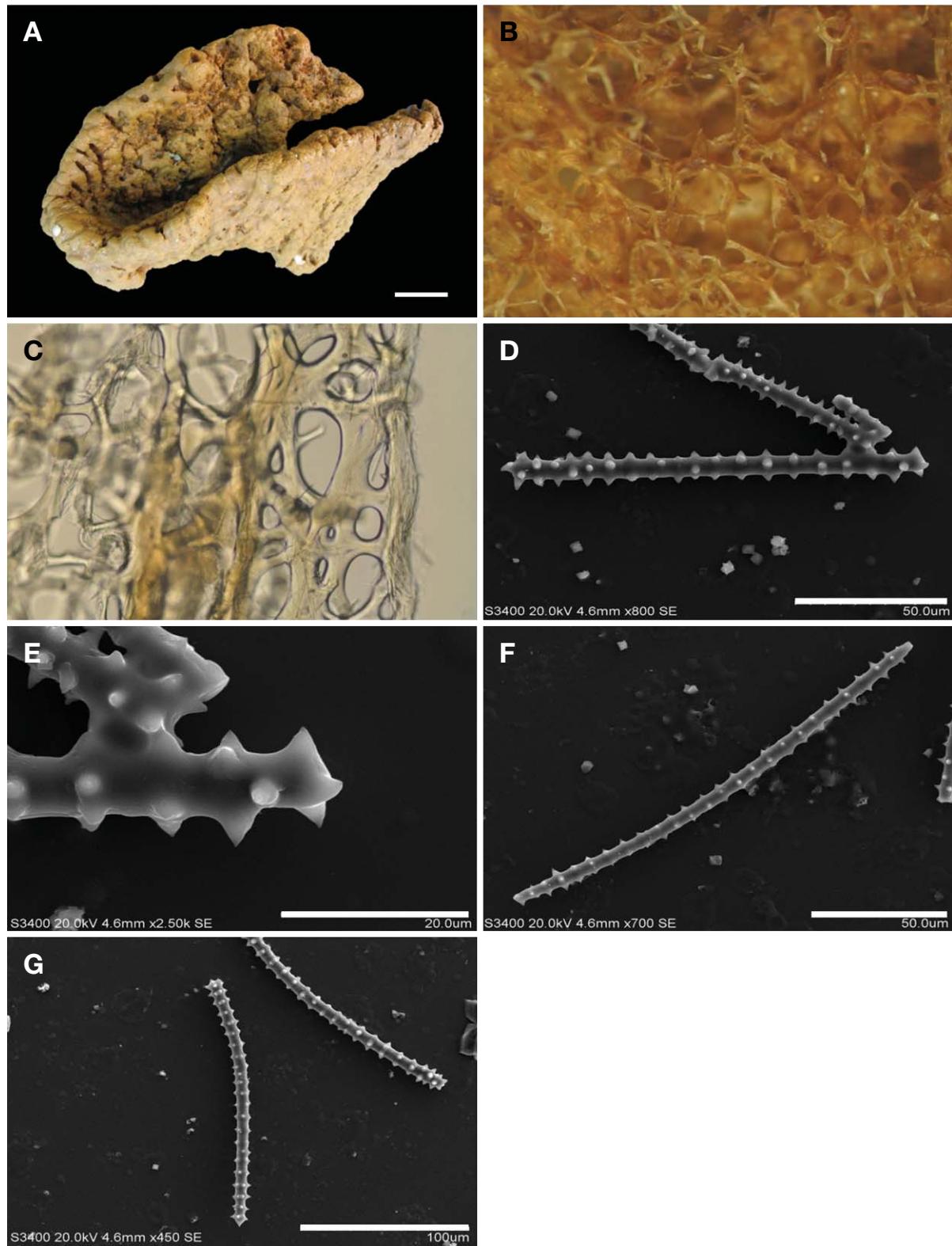
**Remarks.** This species is similar to *Agelas clathrodes* (Schmidt, 1870) in morphology but it clearly differs in its fibres. Primary fibres of the new species are larger. The mesh in *A. clathrodes* is narrower than that of this new species and the spicules are longer. The new species has numerous acanthoxeas. *Agelas clathrodes* from a Caribbean specimen is strong cavernous in choanosome but this new species has very weak cavernous.

#### <sup>1\*</sup>*Agelas vansoesti* n. sp. (Fig. 6)

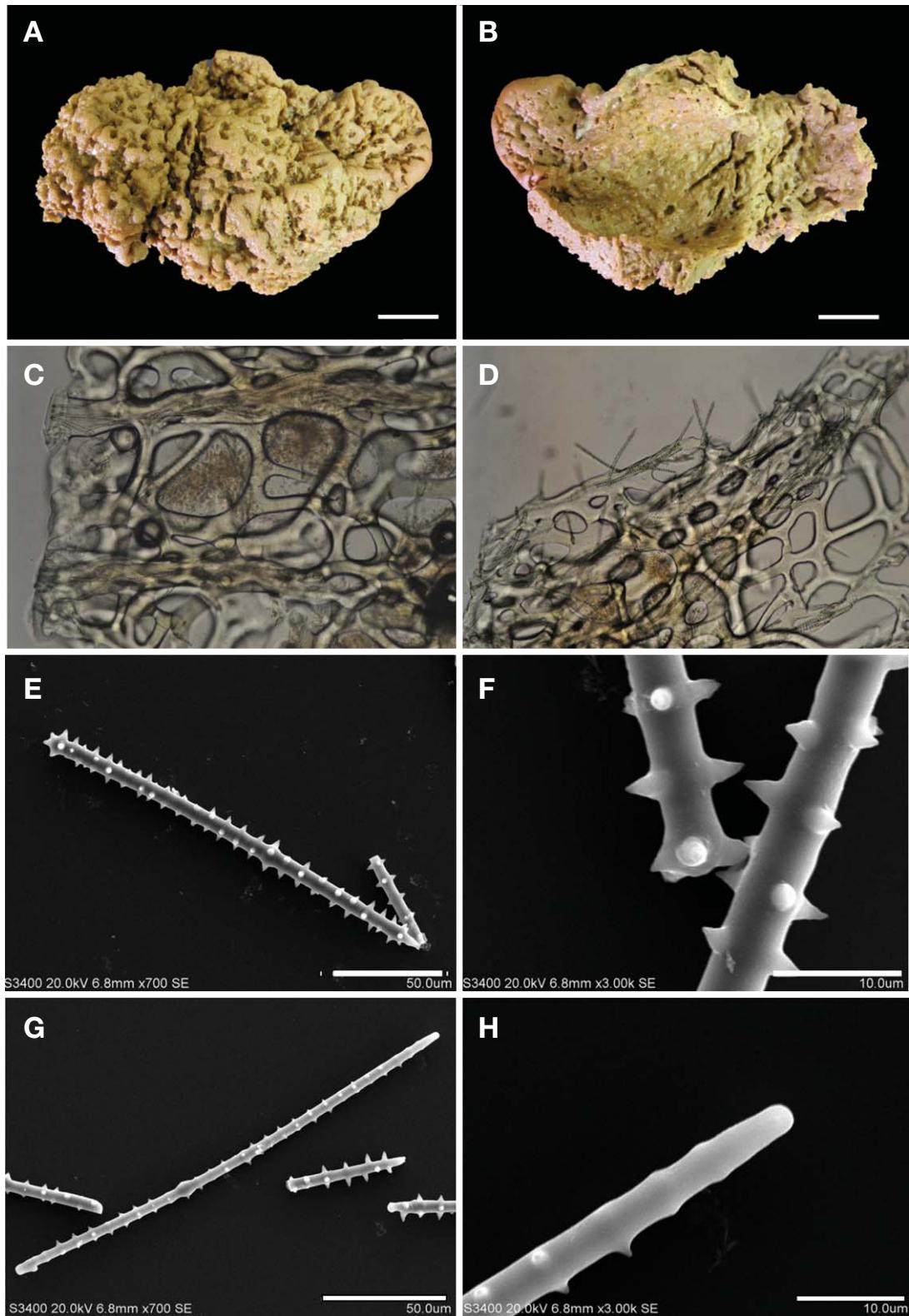
**Type specimen.** Holotype (MABIK IV00151594), Foko Fu-kunsral, Kosrae, Micronesia, 19 Jan 2011, Rho HS, by scuba, depth 17 m, deposited in the MABIK, Seocheon, Korea.

**Description.** Flabellate, cup-shaped, size up to 23 × 10 × 1.5 cm. Surface very rough inside but outside smooth with slight protuberances. No oscules. Consistency firm and difficult to tear. Color yellowish brown in life.

Korean name: <sup>1\*</sup>벤소스티아겔라스해면(신칭)



**Fig. 6.** *Agelas vansoesti* n. sp. A, Entire animal; B, Perpendicular section; C, Skeletal structure; D, Acanthostrongyle; E, Head of acanthostrongyle; F, Acanthoxea; G, Acanthostyle. Scale bars: A=3 cm, D, F=50 μm, E=20 μm, G=100 μm.



**Fig. 7.** *Agelas incrustans* n. sp. A, Entire animal; B, Underside of sponge; C, Primary and secondary fibres; D, Echinated fibres; E, Acanthostyle; F, Head of acanthostyle; G, Thin acanthostyle; H, Head of thin acanthostyle. Scale bars: A, B=3 cm, E, G=50 µm, F, H=10 µm.

**Skeleton.** Ectosome a thin membrane, very resilient with cored fibres and free spicules. Choanosome a irregular reticulation with loose primary fibres 150 µm in diameter, heavily cored and echinated, primary fibres form a simple fascicle; secondary fibres 60–70 µm in diameter, not cored and rarely echinated; tertiary fibres 20–30 µm in diameter, not cored and rarely echinated, The secondary fibre mesh is 30–350 µm in diameter.

**Spicules.** Acanthostyles 180–200 × 8–10 µm, number of spine whorls, 24. Acanthostrongyles 160–200 µm, number of spine whorls 19–24. Acanthoxeas 200–220 µm, number of spine whorls 22–24 (very rare).

**Etymology.** This species name *vansoesti* is named after Dr. Rob W.M. van soest, Naturalis Biodiversity Center, Department of Marine Zoology, The Netherlands, a marine sponge taxonomist.

**Remarks.** The new species is similar to *Agelas clathrodes* in morphology, but differs in skeletal structure. The new species has primary, secondary and tertiary fibres. Spicules in the new species are longer than that of *A. clathrodes*. This new species has many acanthostrongyles.

#### <sup>1\*</sup>*Agelas incrustans* n. sp (Fig. 7)

**Type specimen.** Holotype (MABIK IV00151595), Molsron Tukunsru Village, Kosrae, Micronesia, 22 Oct 2012, Rho HS by scuba, depth 17 m, deposited in the MABIK, Seocheon, Korea.

**Description.** Thick encrusting sponge, size up to 18 × 10 × 2 cm. Surface with many protuberances but smooth. Texture hard. Color light orange in life.

Skeleton regularly arranged, interior not cavernous; many fasciculate, primary fibres with numerous spicule; echinating spicules rare. Mesh variable. Primary fibres 140–150 µm in diameter and make a fascicle complex, spaced at intervals of 400 µm in diameter. Secondary fibres 30–40 µm. Mesh 31–179–184–238 µm with rare echinating spicules.

Spicule. Acanthostyles 170–210 × 5–10 µm, number of spine whorls 21–23.

**Etymology.** This species named after the encrusting habit.

**Remarks.** This species is similar to *Agelas clathrodes* Schmidt, 1870 in external shape but the new species is distinguished from *A. clathrodes* by its encrusting habit and relatively solid interior.

## DISCUSSION

The genus *Agelas* has only one spicule type and shows a very

similar range of spicule sizes in all species. Lehnert and Van Soest (1998) stated that the spicule characters of *Agelas* species are not useful for species discrimination as they exhibit a large variation within each specimen. In most reported papers, there are few details on skeletal structure. Our study was focused on skeletal structure. And we divided the specimens into three group habitat; tuberculate surface with brush-like terminal, repent type and thick encrusting with smooth surface or funnel shape.

These three group show different spicule types. Rough surface with brushed spicules have very distinct verticilliate shape and thick diameter. In repent sponge, spicules have irregular spine of whorls and thinner than brush-like spicules. Thick encrusting or funnel shape sponge has also irregular spine of whorls but thicker than repent sponge.

Although Kosrae is geographically close to Truk, Kosrae has a high diversity of species of *Agelas* compared with Truk. The genus *Agelas* has resilient fibres like keratose sponges, but it is difficult to distinguish between primary and secondary fibres. *Agelas* is also difficult to tear, because it has tougher fibres than those in keratose sponges.

Thirteen species of Indo pacific *Agelas* (one species from Indonesia) are known but the majority is from the Caribbean (17 spp.) (De Voogd et al., 2008), thirteen species from the Caribbean. Kosrae shows the high diversity of *Agelas* species.

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